[0648] Based on these measurement results, a lift-off resist layer **372** is formed on the multilayer film **371**, paying attention to the width dimension C of the insensitive regions D and D measured through the micro track profile method. Referring to **FIG. 40**, undercuts **372***a* and **372***a* are formed on the underside of the resist layer **372**. The undercuts **372***a* and **372***a* are formed above the insensitive regions D and D, and the sensitive region E of the multilayer film **371** is fully covered with the resist layer **372**.

[0649] In a manufacturing step shown in **FIG. 41**, both sides of the multilayer film **371** are cut away by etching, and in a manufacturing step shown in **FIG. 42**, hard bias layers **373** and **373** are formed on both sides of the multilayer film **371**. In this invention, the sputtering technique, used to form the hard bias layers **373** and **373**, intermediate layers **376** and **376**, and electrode layers **375** and **375**, is preferably at least one sputtering technique selected from an ion-beam sputtering method, a long-throw sputtering method, and a collimation sputtering method.

[0650] In accordance with the present invention, as shown in **FIG. 42, a** substrate **370** having the multilayer film **371** formed thereon is placed normal to a target **374** having the same composition as that of the hard bias layers **373** and **373**. In this setup, the hard bias layers **373** and **373** are grown in a direction normal to the multilayer film **371** using the ion-beam sputtering method, for instance. The hard bias layers **373** and **373** are not grown into the undercuts **372***a* and **372***a* of the resist layer **372** arranged on the multilayer film **371**. Referring to **FIG. 42, a** layer **373***a* having the same composition as that of the hard bias layers **373** and **373** is formed on top of the resist layer **372**.

[0651] Intermediate layers **376** and **376** are grown on the hard bias layers **373** and **373** through ion-beam sputtering method. In this case, the target **374** is replaced with a target **377** having the composition of a high-resistivity material selected from the group consisting of $TaSiO_2$, TaSi, $CrSiO_2$, CrSi, WSi, $WSiO_2$, TiN, and TaN, or an insulating material selected from the group consisting of Al_2O_3, SiO_2, Ti_2O_3, TiO, WO, AlN, Si_3N_4, B_4C, SiC, and SiAlON. The intermediate layers **376** and **376** are not deposited into the undercuts **372***a* and **372***a* of the resist layer **372** arranged on the multilayer film **371**. As shown in **FIG. 42, a** layer **376***a* having the same composition as that of the intermediate layers **376** and **376** is formed on the resist layer **372**.

[0652] In a manufacturing step shown in **FIG. 43**, the electrode layers **375** and **375** are obliquely grown on the hard bias layers intermediate layers **376** and **376** at an angle to the multilayer film **371**. In this case, the electrode layers **375** and **375** are grown into the undercuts **372***a* and **372***a* formed on the underside of the resist layer **372** arranged on top of the multilayer film **371**.

[0653] Referring to **FIG. 43**, the electrode layers **375** and **375** are deposited on the hard bias layers **373** and **373** through the ion beam splutter method, while the substrate **370**, having the multilayer film **371** thereon, is rotated in a plane at an angle with respect to a target **378** having the same composition as that of the electrode layer **375**. The electrode layer **375** sputtered at an oblique angle is grown not only on the intermediate layer **376** but also into the undercut **372***a* of the resist layer **372** formed on the multilayer film **371**. Specifically, the electrode layer **375** grown into the undercut **372***a* covers the insensitive region D of the multilayer film **371**.

[0654] In a manufacturing step shown in **FIG. 44**, the resist layer **372** shown in **FIG. 43** is removed using a resist stripper, and this completes a magnetoresistive-effect device having the electrode layers **375** and **375** formed on top of the insensitive regions D and D of the multilayer film **371**.

[0655] In accordance with the present invention, the intermediate layer, made of a high-resistivity material having a resistance higher than that of the electrode layer or an insulating materia, is formed between the hard bias layer and the electrode layer. With the electrode layer formed to extend over the multilayer film, the sense current shunting to the hard bias layer is controlled, and the sense current directly flows from the electrode layer to the multilayer film. The magnetoresistive-effect device of this invention thus presents a high reproduction gain and a high reproduction output, compared with the conventional art.

[0656] The use of the intermediate layer permits the thickness of the electrode in the contact area thereof with the multilayer film to be thinned. This arrangement reduces the size of a step between the top surface of the electrode layer and the top surface of the multilayer film, and forms an upper gap layer over the border area between the electrode layer and the multilayer film, with an improved step coverage and with no film discontinuity involved, and provides sufficient insulation.

[0657] The electrode layers overlapping the multilayer film are formed to extend over the insensitive regions that occupy both end portions of the multilayer film. In this arrangement, the sense current predominantly flows into the sensitive region that is centrally positioned in the multilayer film and substantially exhibits the magnetoresistive effect. The reproduction output is even further increased.

What is claimed is:

1. A magnetoresistive-effect device comprising a multilayer film comprising an antiferromagnetic layer, a pinned magnetic layer, which is deposited on and in contact with said antiferromagnetic layer, and the magnetization direction of which is pinned through an exchange anisotropic magnetic field with said antiferromagnetic layer, and a free magnetic layer, separated from said pinned magnetic layer by a nonmagnetic electrically conductive layer, a pair of hard bias layers, deposited on both sides of said multilayer film, for orienting the magnetization direction of said free magnetic layer perpendicular to the magnetization direction of said pinned magnetic layer, and a pair of electrode layers respectively deposited on said hard bias layers, wherein said electrode layers extend over said multilayer film.

2. A magnetoresistive-effect device according to claim 1, wherein said multilayer film is fabricated by successively laminating said antiferromagnetic layer, said pinned magnetic layer, said nonmagnetic electrically conductive layer, and said free magnetic layer in that order from below, said antiferromagnetic layer laterally extends from the layers laminated thereon, and a pair of hard bias layer, a pair of intermediate layers, and a pair of electrode layers are respectively laminated on a pair of metallic layers respectively deposited on said antiferromagnetic layers in said laterally extending regions thereof.

3. A magnetoresistive-effect device according to claim 1, wherein said electrode layer feeds a sense current to each of said pinned magnetic layer, said nonmagnetic electrically conductive layer, and said free magnetic layer.